

CLAIMS

1 1. A method for simulating film grain comprising the steps of:
2 receiving image information representative of an image from which film grain has
3 been at least attenuated;
4 receiving film grain information that includes at least one parameter among a set
5 of possible parameters specifying different attributes of the film grain previously in the
6 image;
7 selecting a model for simulating grain;
8 simulating the film grain in accordance with the selected model and the at least
9 one parameter; and
10 merging the simulated film grain into the image.

1 2. The method according to claim 1 wherein the set of parameters ϵ includes
2 a plurality of correlation parameters and a plurality of intensity-independent parameters.

1 3. The method according to claim 2 wherein at least one correlation
2 parameter defines a spatial correlation in a perceived pattern of film grain.

1 4. The method according to claim 2 wherein at least one correlation
2 parameter defines a correlation between color layers.

1 5. The method according to claim 2 wherein at least one correlation
2 parameter defines a temporal correlation resulting from previous processing the image
3 sequence.

1 6. The method according to claim 2 wherein at least one intensity-
2 independent parameters defines an aspect ratio of the film grain.

1 7. The method according to claim 1 wherein at least one parameter defines
2 intensity of a random component of the film grain.

1 8. The method according to claim 2 wherein at least one of the intensity-
2 independent parameters defines a color space and blending mode operation used to
3 merge the simulated film grain with the image.

1 9. The method according to claim 1 wherein the message containing the film
2 grain information is transmitted out-of band with the image representative information.

1 10. The method according to claim 1 wherein the message containing the film
2 grain information is transmitted in band with the image representative information.

1 11. The method in accordance with claim 2 where the set of parameters are
2 computed in accordance with a second order auto regression representation of the
3 spatial correlation and a first order regression representation of the cross-color and
4 temporal correlations.

1 12. The method according to claim 3 wherein the at least one parameter
2 describing the spatial pattern of the grain is established in accordance with a spatial
3 convolution model.

1 13. The method according to claim 3 wherein the at least one parameter
2 describing the spatial pattern of the grain is obtained from cut frequencies of a filter in
3 the Fourier domain.

1 14. The method according to claim 1 wherein the set of selecting the model
2 further comprises the step of selecting an additive grain model.

1 15. The method according to claim 1 wherein the set of selecting the model
2 further comprises the step of selecting a multiplicative grain model.

1 16. The method according to claim 1 wherein the step of selecting the model
2 further comprises the step of selecting a model that simulates the film grain by
3 convolving a set of random numbers by a linear, time-invariant, digital-filter h defined in
4 the form of:

$$h = (h_0, h_1, h_2, h_3, \dots h_n)$$

6 wherein the set of parameters includes filter coefficients.

1 17. The method according to claim 1 wherein the step of selecting the model
2 further comprises the step of multiplying in the frequency domain by a Fourier Transform
3 of an impulse response H and a Fourier Transform set of random numbers to yield a
4 simulated grain result $Y(u)$ in accordance with the relationship

$$Y(u) = X(u) \cdot H(u)$$

1 18. Apparatus for simulating film grain, comprising :
2 first means for: (1) receiving image information representing an image from which
3 film grain has been substantially attenuated; (2) receiving film grain information that
4 includes at least one parameter among a set of possible parameters specifying different
5 attributes of the film grain; (3) selecting a model for simulating grain; and (4) simulating
6 the film grain in accordance with the selected model and the at least one parameter; and
7 second means for merging the simulated film grain with the image .

1 19. The apparatus according to claim 18 wherein the model selected by the
2 first means comprises an additive grain model.

1 20. The apparatus according to claim 18 wherein the model selected by the
2 first means comprises a multiplicative grain model.

1 21. The apparatus according to claim 18 wherein the model selected by the
2 first means simulates the film grain by convolving a set of random numbers x by a linear,
3 time-invariant, digital-filter h defined in the form of:

$$h = (h_0, h_1, h_2, h_3, \dots h_n)$$

5 wherein the set of parameters includes filter coefficients.

1 22. The apparatus according to claim 18 wherein the model selected by the first
2 means simulates film grain by multiplying in the frequency domain by a Fourier
3 Transform of an impulse response H and a Fourier Transform set of random numbers to
4 yield a simulated grain result $Y(u)$ in accordance with the relationship:

$$Y(u) = X(u) \cdot H(u).$$